Identifying Student Misunderstandings using Constructed Responses

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Abstract
- Goal: Infer student misunderstandings from wrong constructed answers, without requiring manual grading for each student
  1. Instructors manually label top K wrong answers according to misunderstandings they may indicate
  2. Co-occurrence used to propagate labels to other students/answers
  3. Use on subsequent student cohort(s) as "misunderstanding detector"
- Finding: Wrong answer co-occurrence provides promising signal of misunderstanding

Materials
- Video playlist link
- Poster pdf
http://goo.gl/C06cvd

How identify misunderstandings?

Misunderstanding in a Student Definition:
When a student provides two distinct wrong answers that demonstrate the same misunderstanding

Getting the misunderstanding labels

Case Study Results
- 9 Lab Assignments with 3332 to 889 students
- Two raters categorized and labeled Top-K=100 and for evaluation 50 student fully labeled set
  • Category inter-rater reliability: 0.91
  • Fraction of labels given by both raters: 0.61

Using only Rule 1 to identify misunderstandings

Adding Rule 2: Propagation

4 Co-occurrence Metrics:
1. Coherence 3. Cosine
2. Odds Ratio 4. Kulczynski

Uninformed Baseline:
Instead of high co-occurrence propagate with probability p.

Modified Area Under the Curve (AUC)

Using Rule 2 to propagate labels

Example Question

\[
\text{def how_big(x):}
\]
\[
\text{if x > 10:}
\]
\[
\text{print("huge")}
\]
\[
\text{elif x > 5:}
\]
\[
\text{return "big"}
\]
\[
\text{elif x > 0:}
\]
\[
\text{print("small")}
\]
\[
\text{else:}
\]
\[
\text{print("nothing")}
\]

Correct: Answer marked wrong due to typo, (ex: "True vs True")
Wrong: Answer is actually incorrect.
Not an answer (NA): Intended as action to do something else, (ex: "exit")

Wrong answer co-occurrence with one not in Top-K

Fractions of labels given by both raters:
- 0.61

Countable Distinct Answers

Is it possible? To

Detect misunderstandings in students
Use constructed responses
Not overwhelm the instructors

Yes, if answers are

Why use constructed response?

More information can be gained from constructed response questions than selected response. Especially from the wrong answers.

However, more students means more constructed responses.

Focusing on finding repeated mistakes.

Using only Rule 1 to identify misunderstandings

Rule 1: Directly apply definition
If there are two wrong answers that share a label, the student has that misunderstanding

Rule 2: Propagation
1. Two wrong answers, with one not in Top-K
2. Wrong answer in Top-K has label student does not have
3. Two wrong answers have high co-occurrence

Future Work
- Investigate propagation methods
- Use model to deliver guidance messages to help fix misunderstanding
- Investigate effectiveness of different kinds of guidance messages